COMPARISON OF THE CONTRAFACTUAL APPROACHES TO THE IMPACT EVALUATION OF AGRICULTURAL POLICIES (EXAMPLE OF COOPERATIVES IN ZAMBIA)

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INTRODUCTION

- Within the context of agricultural and rural development, African governments together with international donors' and NGOs' experiment with various agricultural policies...
  - aimed at small farmers and improvement of their livelihoods
- Recently, one of the most popular policies has been new interest in producer groups and cooperatives,...
  - where several benefits from the collective action of small producers are expected

INTRODUCTION

- Cooperatives serve as an avenue where projects effectively reach the rural areas to improve rural welfare and livelihoods (Valentinov 2007; Wanayama et al. 2009; Markelova 2009)
- Cooperatives also serve as a platform for building capacity, exchanging information and innovation in rural areas (Rao & Qaim 2011; Fischer & Qaim 2012)
- However, the **effectiveness of such policies seems to be mixed and systematic impact evidence is missing**
- The existing evidence also indicates that the impact evaluation outcomes related to the agricultural cooperatives are dependent on the **choice of methodological approach**

MAIN AIM

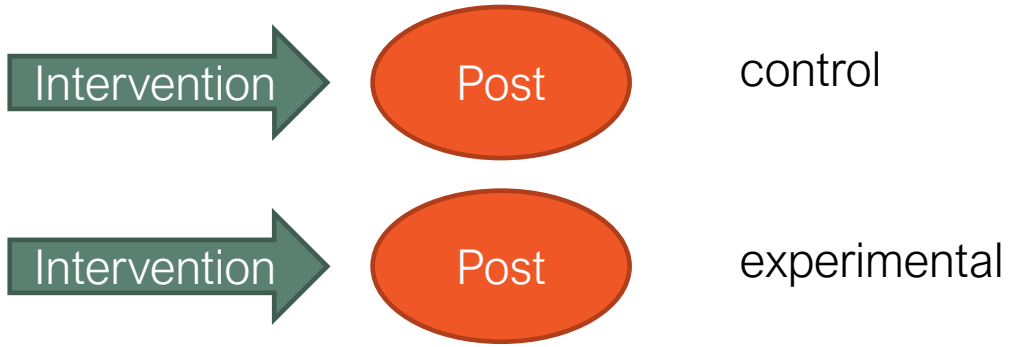
- Therefore, the aim of our study is to review, compare and discuss various **counterfactual approaches** to evaluating the impact of newly created cooperatives on the various types of economic, social and environmental benefits for the members
  - Quasi/experimental, cross sectional data from Western Zambia
    - No pre-intervention, baseline data
    - Control group
  - Problem of non-random sample, lack of manipulation and potential self-selection into the treatment (group)

METHODOLOGICAL APPROACHES

- Evaluating using groups (Treatment/participants and control groups/non-participants)
  - Standard potential outcome model
    - Independent sample T-test (unmatched)

Basic Assumptions for potential outcome model

- Treatment better than control because of the intervention
- Control will be better than treatment if they received intervention



$$T_1 = Y_{1i} - Y_{0i}$$

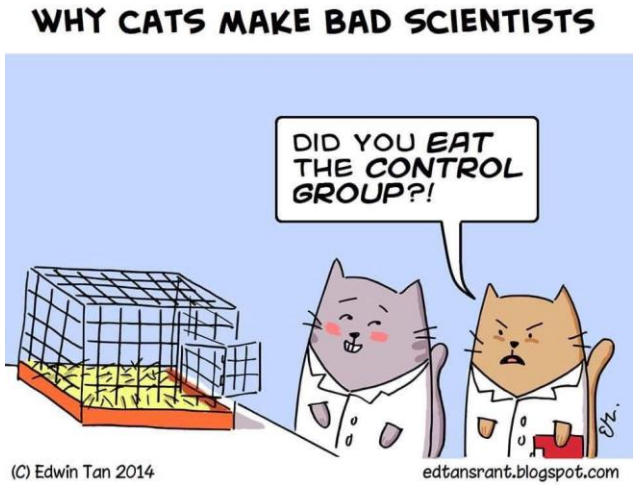
- Y_{1i} = potential outcome for unit **i** in case of participation in the intervention
- Y_{0i} = potential outcome for unit **i** in case of non-participation in the intervention
- T_1 = the effect of participation in intervention on unit **i**, relative to effect of non-participation based on a response variable Y

PROBLEMS EVALUATORS FACE BY COMPARING GROUPS (TREATMENT AND CONTROL GROUPS)

Selection bias

- Observable bias (examples, difference in educational level, age, gender) → External validity affected
- Unobservable/hidden bias (examples, member of social groups, access to extension service) → Internal validity affected

- Dealing with these problems yield different impact results



DEALING WITH OBSERVABLE BIAS

- Propensity score matching by (Rosenbaum and Rubin, 1983)
  - Maintain the treatment and control group on a level playing
  - Two stages:
    - First stage, PSM generates propensity scores P(X) from a probit model, which indicate the probability of a farmer to be a group member
      - Then construct a control group by matching group members to nonmembers according to their propensity scores
      - Members for whom an appropriate match cannot be found, as well as nonmembers not used as matches, are dropped from the further analysis
  - In the second stage, the PSM estimates the ATT of group membership on outcome variable Y using matched observations of members and nonmembers

PROPENSITY SCORE MATCHING

$$ATT = EP(X)(C=1)\{E[Y(1)|C=1,P(X)]|-[E\ Y(0)|C=0,P(X)]$$

- where Y(1) and Y(0) are the outcomes for those farmers in the treated and control groups without treatment, respectively,
- while C=1 for treated farmers and C=0 for control farmers
- The difference between the two outcomes refers to the treatment effect on the treated (ATT)

VARIABLES USED TO GENERATE THE PROPENSITY SCORES (PROBIT MODEL)

Cooperative Characteristics

- Cooperative investment
- Relationship with leaders
- Cooperative as marketing channel

(Verhees et al. 2015)

Social Characteristics

- Voice
- Acceptance
- Reciprocity of relationship

(Mojo et al. 2015)

Household & Farm Characteristics

- Age of farmers
- Gender
- Land and Farm size
- Cooperative experience
- Wealthiness of the farmer

(Mojo et al. 2017; Fischer & Qaim 2014)

Institutional Characteristics

- Extension access

(Mojo et al. 2017; Fischer & Qaim 2012)

DEALING WITH UNOBSERVABLE BIAS

- Check for sensitivity of PSM to hidden bias-Rosembaum r bounds
- Endogenous treatment effect models (Lokshin & Sajaia, 2004 ;StataCorp, 2017)
  - Linear regression with endogenous treatment effects
  - Endogenous switching regression
  - Endogenous switch probit regression (binary outcome)

  - Use of instruments to deal with endogeneity (member of social groups, access to extension service)

SAMPLE SIZE

Target Group

- Participants and non-participants smallholder rice farmers

Sample Size

- 72 Participants and 143 non-participants of rice marketing cooperatives in the Western province of Zambia- 215

Sampling Technique

- Purposive

DATA COLLECTION

Collection Technique - Interviews of members with structured questionnaire

Instrument - Nest Forms mobile application

Several trained enumerators

Additional interviews with some members and leaders for qualitative and deeper insights

RESULTS

ECONOMIC IMPACT OF MEMBERS PARTICIPATION IN RICE COOPERATIVES

CASE STUDY FROM WESTERN ZAMBIA

PROBIT MODEL FOR ASSIGNMENT OF PROPENSITY SCORES

Table 1. Probit Model Results of Determinants' Commitment to the Cooperative

Commitment	Coefficient	Marginal Effects
Gender	0.13 (0.22)	0.04
Age (years)	-0.01 (0.01)	-0.01
Education (years)	**0.07 (0.04) *** **	**0.02**
Farm size (Ha)	-0.01 (0.05)	-0.01
Distance to cooperative centre (km)	0.02 (0.01) **	0.01
Number of crops in addition to rice	-0.06 (0.08)	-0.02
Length of membership in cooperative (years)	0.03 (0.02)	0.01
Perceived acceptance	**0.55 (0.17) *** **	**0.18**
Perceived trust	**-0.41 (0.18) *** **	**-0.13**
Amount of investment	**0.01 (0.01) *** **	**0.01**
Constant	-2.39 (1.24) *	
Wald χ2 (10)	77.45	
p-value	0.00	
Pseudo R2	0.28	
Log pseudolikelihood	-99.03	
Number of observations	215.00	

MATCHING QUALITY

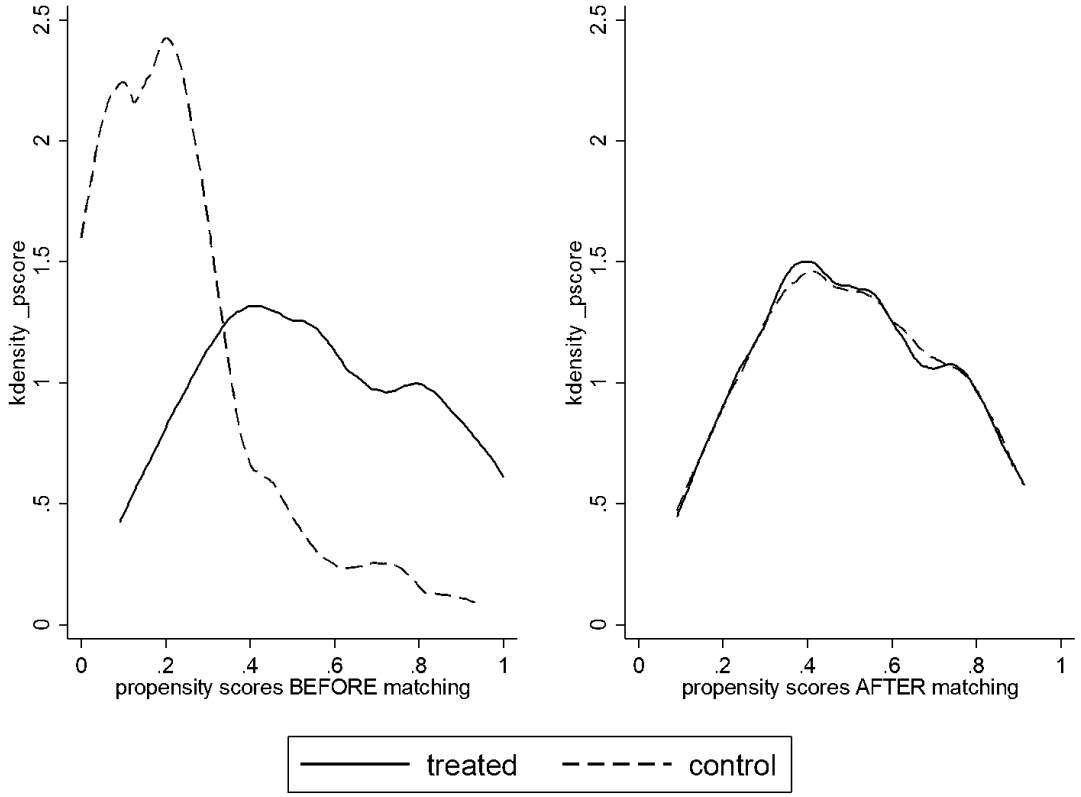


Figure 1. Propensity Score Distribution

RESULTS FOR UNMATCHED AND MATCHED

- Table 2. Economic Impact of Commitment to cooperative

Variable	Algorithms	Treated	Controls	ATT	S.E.	z
Yield (kg)	Unmatched	2515.07	830.28	1684.79	218.99	7.69***
	Nearest Neighbour	2266.66	1118.93	1147.72	425.70	2.70***
	Radius	2342.95	1023.49	1319.46	289.06	4.56***
	Kernel	2515.06	1022.20	1492.86	376.42	3.97***
Gross Margin (ZK)	Unmatched	1394.81	-3618.79	5013.60	1381.93	3.63***
	Nearest Neighbour	618.93	-1103.43	1722.37	2317.49	0.74
	Radius	1035.17	-2444.25	3745.05	2037.43	1.71*
	Kernel	1394.80	-2211.57	3606.37	1823.53	1.98**

Note: ***, **, and * represent 1%, 5%, and 10% significance levels, respectively; 1 USD = 14.77 ZK

CONSIDERATION FOR ENDOGENEITY

Table 3. *Endogenous Treatment Regression Estimate for Yield (Instruments=Acceptance and trust)*

Yield	Coefficient
Gender	247.55 (202.69)
Age	-8.99 (7.01)
Education	-21.26 (26.84)
Farm size	**128.41 (47.68) *** **
Experience	**43.55 (20.61) ** **
Quantity of seed	-1.71 (0.28)
Quantity of labour	**42.51 (10.40) *** **
Participation	1796.54 (355.26) ***
Constant	439.61 (485.20)
Participation	**Coefficient**
Gender	0.14 (0.22)
Age	-0.01 (0.01)
Education	0.06 (0.02) **
Farm size	-0.01 (0.05)
Distance	0.02 (0.01) **
Trust	-0.44 (0.18) **
Acceptance	0.62 (0.19) ***
Investment	0.01 (0.01) ***
Constant	2.31 (1.24) *
/athrho	-0.30 (0.16) *
/lnsigma	7.23 (0.05) ***

LR test of indep. eqns. (rho = 0): chi2(1) = 2.99 Prob > chi2 = 0.08

CONSIDERATION FOR ENDOGENEITY

Table 4. Endogenous Treatment Regression Estimate for Gross Margin

Gross Margin	Coefficient
Gender	1122.86 (1148.38)
Age	-11.00 (40.15)
Education	12.20 (149.90)
Farm size	**580.29 (272.62) ****
Experience	177.69 (116.60)
Cost of seeds	-1.45 (1.42)
Cost of labour	**-0.943 (0.09) *****
Participation	9937.14 (1693.74) ***
Constant	-468.71 (2799.91)
Participation	**Coefficient**
Gender	0.14 (0.22)
Age	-0.01 (0.01)
Education	0.06 (0.02) **
Farm size	-0.01 (0.05)
Distance	0.02 (0.01) **
Trust	-0.44 (0.18) **
Acceptance	0.62 (0.19) ***
Investment	0.01 (0.01) ***
Constant	2.31 (1.24) *
/athrho	-0.36 (0.13) ***
/lnsigma	8.96 (0.05) ***

LR test of indep. eqns. (rho = 0): chi2(1) = 4.98 Prob > chi2 = 0.0257

SUMMARY

Table 5. Results of Different Methods

Variable	Algorithms	ATT	S.E.
Yield (kg)	Unmatched	1684.79***	218.99
	PSM	1492.86***	376.42
	Endogenous	1796.54***	355.26
Gross Margin (ZK)	Unmatched	5013.60***	1381.93
	PSM	3606.37**	1823.53
	Endogenous	9937.14***	1693.74

Note: ***, **, and * represent 1%, 5%, and 10% significance levels, respectively; 1 USD = 14.77 ZK

CONCLUSION

- Adopting multiple evaluation methods yields different results and helps the evaluator to be confident in the impact results
- Counterfactual methods yields different results as compared to standard T-test because:
  - External validity is addressed by using PSM to match the two groups
    - The impact is based only on participation in the intervention but not other external factors
  - Internal validity is addressed by using endogenous treatment models
    - Capture the influence of factors which would be hidden to evaluator but have influence on participation in the intervention and the impact of the intervention

REFERENCES

Fischer, E., & Qaim, M. (2012). Linking smallholders to markets: determinants and impacts of farmer collective action in Kenya. *World development*, *40*(6), 1255-1268.

Fischer, E., & Qaim, M. (2014). Smallholder farmers and collective action: what determines the intensity of participation?. *Journal of Agricultural Economics*, *65*(3), 683-702.

Lokshin, M., & Sajaia, Z. (2004). Maximum likelihood estimation of endogenous switching regression models. *The Stata Journal*, *4*(3), 282-289.

Markelova, H., Meinzen-Dick, R., Hellin, J., & Dohrn, S. (2009). Collective action for smallholder market access. *Food policy*, *34*(1), 1-7.

Mojo, D., Fischer, C., & Degefa, T. (2015). Social and environmental impacts of agricultural cooperatives: evidence from Ethiopia. *International Journal of Sustainable Development & World Ecology*, *22*(5), 388-400.

Mojo, D., Fischer, C., & Degefa, T. (2017). The determinants and economic impacts of membership in coffee farmer cooperatives: recent evidence from rural Ethiopia. *Journal of Rural studies*, *50*, 84-94.

Rao, E. J., & Qaim, M. (2011). Supermarkets, farm household income, and poverty: insights from Kenya. *World Development*, *39*(5), 784-796.

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, *70*(1), 41-55.

StataCorp. (2017). Stata treatment-effects reference manual, release 15, 1–322.

Valentinov, V. (2007). Why are cooperatives important in agriculture? An organizational economics perspective. *Journal of institutional Economics*, *3*(1), 55.

Verhees, F. J., Sergaki, P., & Van Dijk, G. (2015). Building up active membership in cooperatives. *New Medit*, *14*(1), 42-52.

Wanyama, F. O., Develtere, P., & Pollet, I. (2009). Reinventing the wheel? African cooperatives in a liberalized economic environment. *Annals of Public and Cooperative Economics*, *80*(3), 361-392.